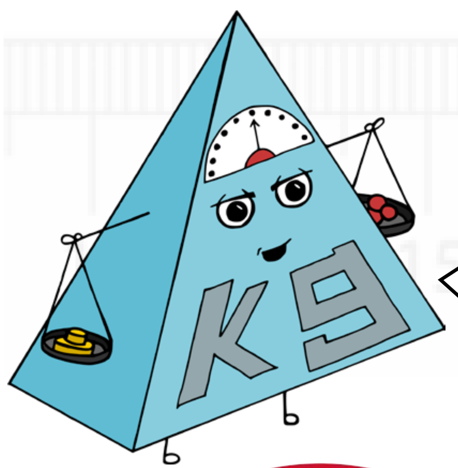
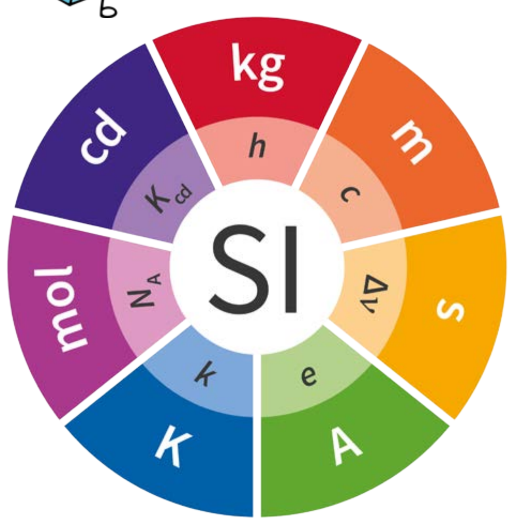
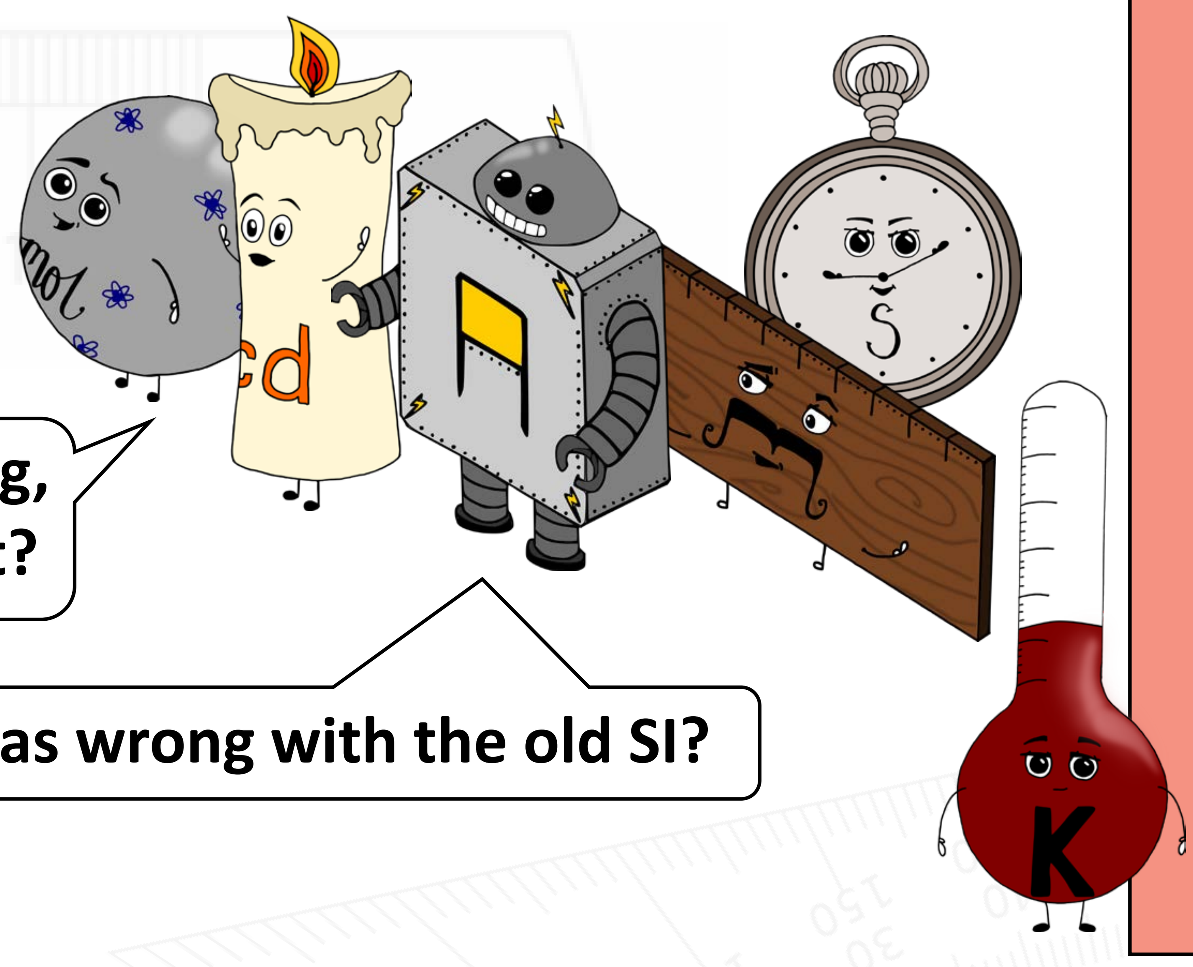
Revision of the SI units



Did you know that we have been revised?

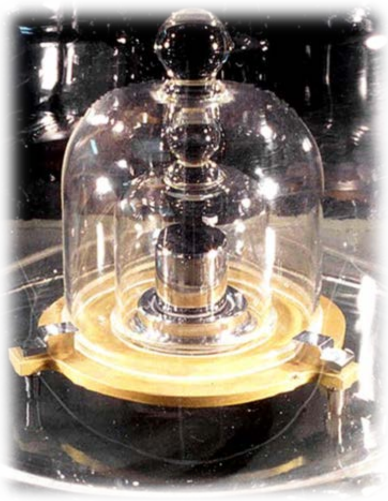




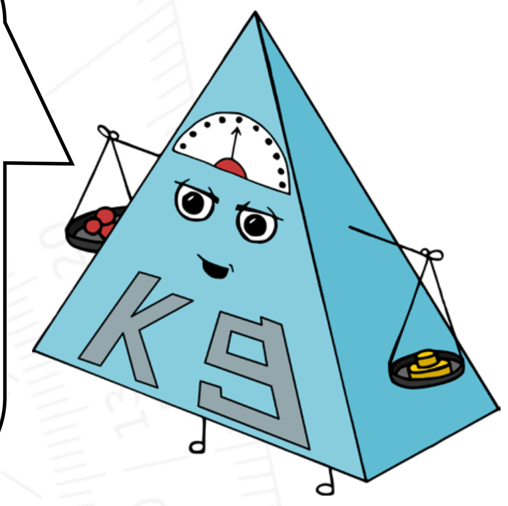
That is amazing, is it important?

What was wrong with the old SI?

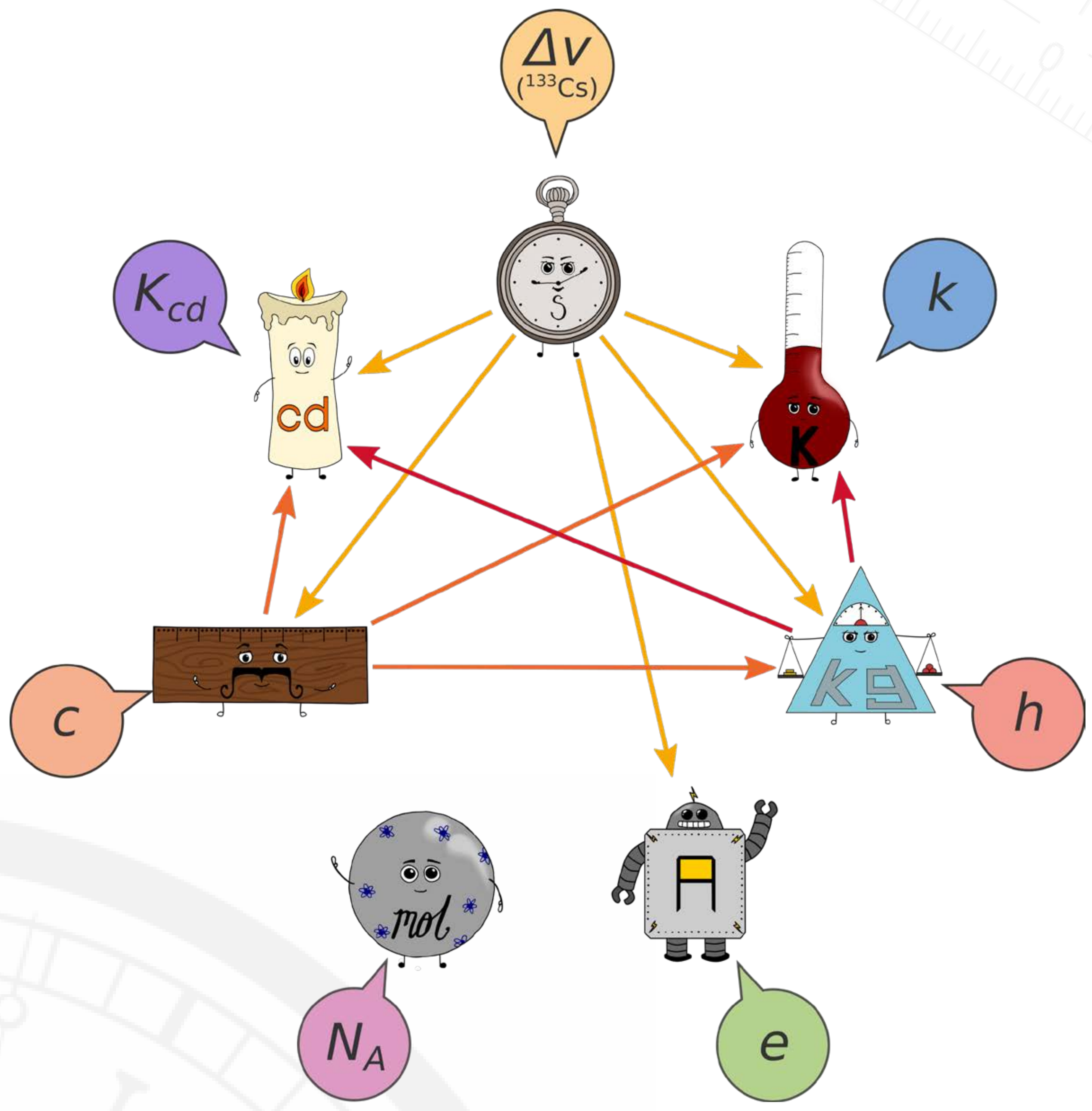
On 16 November 2018 member states of the Convention of the Metre agreed at the 26th General Conference on Weights and Measures to a revision to the international measurement system that underpins all global science and trade. On World Metrology Day, 20 May 2019, the SI unit system underwent the most significant change since its conception. The revised system means that measurements are not linked not to physical artefacts or atomic material properties, but to the unchanging fundamental properties of nature itself.



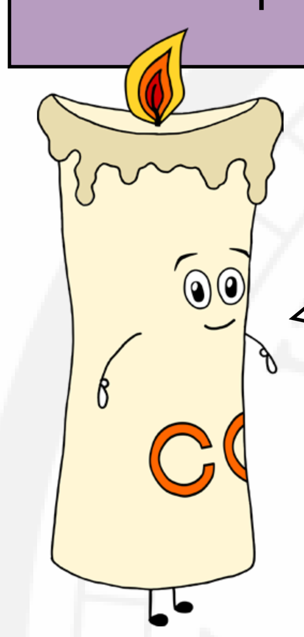
Some of the units used to have reference to physical artefacts, the most famous being the International Prototype of the Kilogram (IPK), which was held in a vault in Paris. The problem with using a physical artefact to define the unit, is that it is subject to changes in properties over time. Since the creation of the IPK in 1889 variations in environmental conditions caused the mass to change, so the definition of the kilogram was linked to something that was unstable over long periods of time.



Scientists have now found an improved and much more reliable way of defining the units. The definition of the units is now completely separate from the technologies used to realise the primary reference standards for the seven SI base units. This means that scientists can measure the seven SI base units with ever increasing accuracy and precision, as more advanced experiments and technologies are designed and implemented.



In the revised SI the new definitions are based on seven of the most important fundamental constants of nature which are now known to a very high precision. Each of the constants is linked to one of the seven SI base units (as shown alongside). After the SI base units are realised through experiment using modern technology, then every single measurement can be linked by a sequence of inter-comparisons (is "**traceable**") to the one or more of the seven SI units.

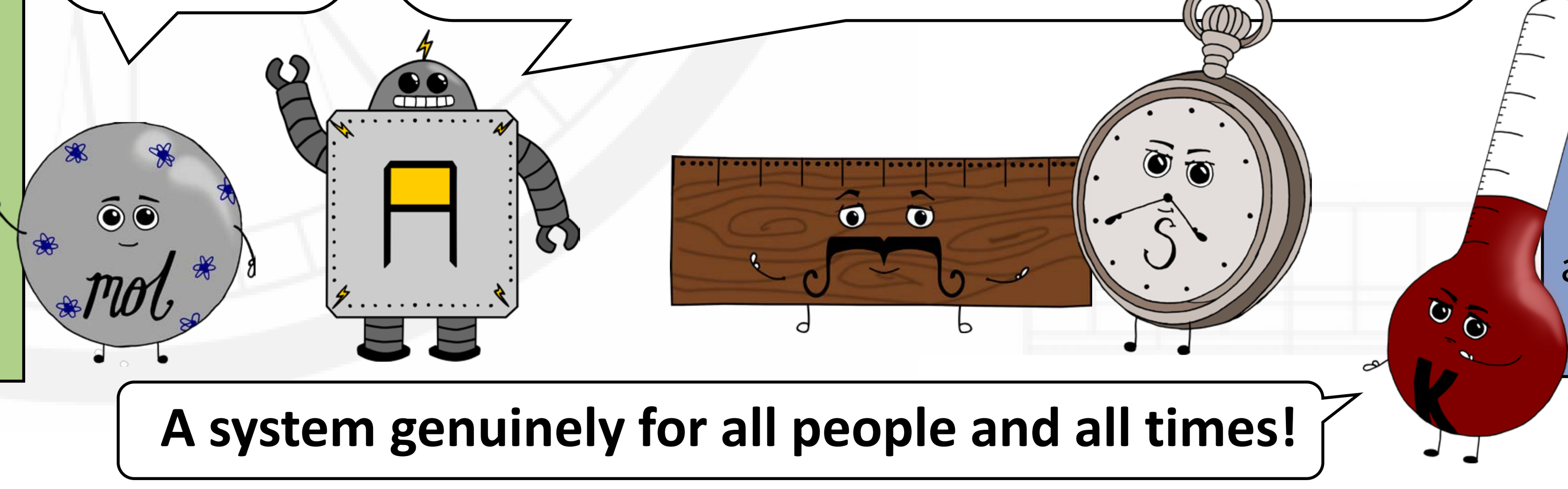


I have heard that one of the ways being developed to realise the reference standard for the kilogram is using a "kibble watt balance", a simple version of which can be built in a school science laboratory. The example shown alongside was constructed at NMISA. The balance uses precise measurements of electrical properties (current, voltage) and a combination of physical constants to define the quantity we call mass.

The famous physicist Max Planck made this extraordinary statement in 1927 about linking the measurement units to constants of nature, that "they will necessarily retain their validity for all times and cultures, even extra-terrestrial and nonhuman."

Is the new system perfect? Can it adapt?

The system will be under continuous improvement as experiments reach higher and higher precision. As we discover new science, or new fundamental constants, these may be incorporated into the system.



Measurement in every aspect of our lives, from everyday activities, to science and engineering, to medicine, to trade and industry, all of it, now has reference to a scale defined by nature. Seven of the fundamental constants are now at the heart of physical measurement.

A system genuinely for all people and all times!

nmisa – National Metrology Institute of South Africa

MeASURe – Metrological and Applied Sciences University Research Unit

DEPARTMENT OF PHYSICS – UNIVERSITY OF CAPE TOWN